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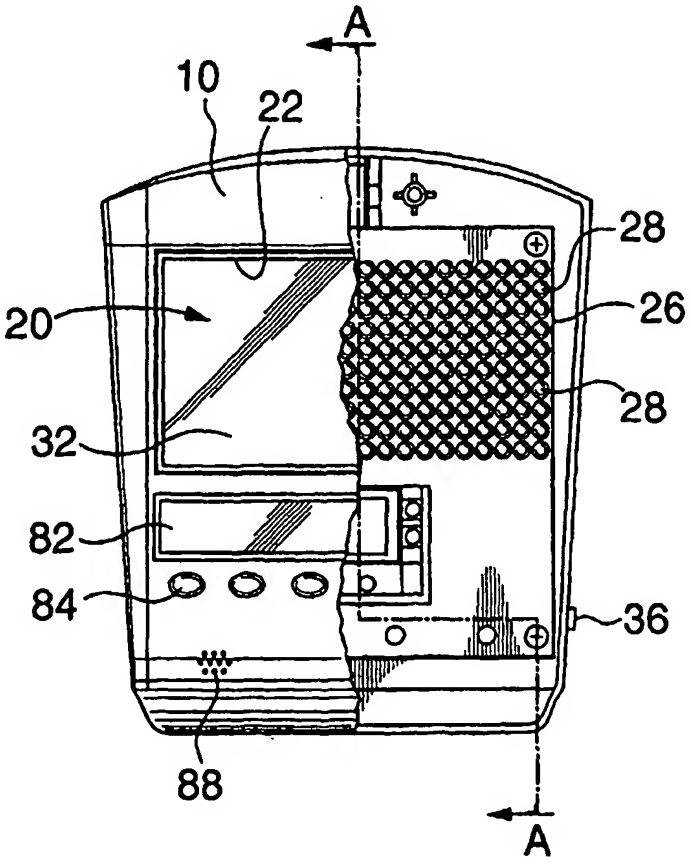
(54) Title: LIGHT THERAPY DEVICE



(57) Abstract: A light therapy device is taught including a light emitting assembly having light emitting diodes (LEDs) as a light source. The light emitting assembly capable of generating 2,500 lux to 7,500 lux at 12 inches. The device is particularly intended for treatment of light deficient disorders like Seasonal Affective Disorder (SAD), circadian sleep disorders and circadian disruptions.

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LIGHT THERAPY DEVICE

FIELD OF THE INVENTION

The present invention relates to an ocular light therapy device and in particular to an ocular light therapy device for treatment of light deficient disorders.

BACKGROUND OF THE INVENTION

There is much support for the use of light therapy to overcome light deficient disorders. It has been proven that treatments involving shining light directly towards a patient's eyes will alleviate or cure light deficient disorders including Seasonal Affective Disorder (SAD), circadian sleep disorders and circadian disruptions associated with jet-lag, shift-work, PMS and bulimia. Light therapy has also been shown effective for fatigue management.

There are two types of light therapy devices presently available. One type of device is large in size and floor or desk mountable. These devices include light sources of fluorescent bulbs. Although they can be moved from one position to another, they are not generally portable. In addition, the light source is quite fragile. The second kind of light therapy devices is head mountable. These devices are formed as eyeglasses or visors. While they are portable, they are not generally accepted by patients for use in public because of their odd appearance when worn on the head. This combined with safety concerns about eye damage given the proximity of the light source to the eye, has resulted in head mountable treatment devices failing to be generally accepted as a light therapy device.

These devices therefore are of limited use for persons requiring a portable and discreet treatment device. A light therapy device is needed for use by, for example, the business traveler, shift workers and far north or south residents that is portable, effective and aesthetically appealing.

SUMMARY OF THE INVENTION

The present invention provides a portable and lightweight hand-held ocular light therapy device. The device is durable, being resistant to damage by normal transport. The device uses light emitting diodes (LEDs) as a source of light. LEDs offer a light source that is lightweight, small in size, simple, durable as well as energy efficient. The device is useful for use in confined spaces, during travel and for in-flight use while being aesthetically acceptable.

In accordance with one aspect of the present invention, there is provided a light treatment comprising: an outer housing including a opening; a light emitting assembly in the housing and operable to emit light through the opening in the housing, the light emitting assembly including a plurality of LEDs capable of generating 2,500 lux to 7,500 lux at 12 inches.

The LEDs include at least some capable of emitting white-light. In one embodiment, the LEDs are arranged in a pattern over an area and the light emitting assembly is selected to emit light from the LEDs along a substantially straight line directly toward the user's eyes. Preferably, a diffuser screen of light diffusing sheet material is positioned over the LEDs to provide a more uniform emission of light. While LEDs do not emit any significant amount of ultraviolet radiation, the diffuser sheet material can include a UV filter, if desired.

The outer housing can include a first member and a second member, the first member and the second member being releasably locked together and the light emitting assembly being storable in the first member and being mountable on the housing such that the housing acts as a base to support the light emitting assembly. In one embodiment, the first and second members are pivotally connected and openable in a manner similar to a book. The first and second members, when closed enclose an inner compartment accessible by opening the first and second members about their

pivotal connection. The light emitting assembly is storable in the inner compartment. In this embodiment, the light emitting assembly can be mountable on the first member and the second member can act as a base.

To facilitate therapy using the device, the housing can also accommodate a therapy calculator for determining a treatment regime based on an input of information. The device can include an adapter for use with DC power, such as in a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a front elevation view of a light therapy device according to the present invention. A portion of the device has been cut away to facilitate illustration of internal components.

Figure 2 is a side elevation view of the light therapy device of Figure 1 with the support leg folded against the housing.

Figure 3 is a sectional view along line A-A of Figure 1.

Figure 4 is a side elevation view of another light therapy device according to the present invention in a closed configuration.

Figure 5 is a side elevation view of the device of Figure 4 in an open configuration, ready for use.

Figure 6 is a front elevation of the device and configuration of Figure 5.

Figure 7 is an elevation of a device for permitting mounting of a light therapy device in a passenger compartment of a vehicle. The device is aligned for insertion into a power port of a vehicle and a light therapy device is aligned for insertion into the docking bay of the device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Figures 1 to 3, a light therapy device according to one embodiment of the present invention is shown. The device is small in size and resembles a large calculator or hand-held computer. Preferably, the outside dimensions of the device are less than about 7 inches wide, 7 inches high and 1.5 inches deep. The size can be

varied as desired and with consideration as to portability, convenience and the components that must be contained therein.

The device includes an outer housing 10. The housing is preferably formed of a durable, impact resistant material such as, for example, a polymer (i.e. nylon, thermoplastic or blends thereof). Preferably, all housing parts are of minimal thickness to provide suitable impact resistance and support for internal components while minimizing the weight of the device. The housing can be formed, as shown, in parts secured together by screws 12 or other fastening means.

The housing carries a light emitting assembly 20. The light emitting assembly is mounted in the housing such that in operation light emitted therefrom is directed out through an opening 22 in the housing.

Light emitting assembly 20 includes a printed circuit (PC) board 26 providing electrical connection for light emitting diodes 28. The LEDs are spaced apart on the board, with consideration as to their light output and wavelength, such that the assembly emits a light of illumination adequate for treatment of light deficient disorders. In particular, the light emitting assembly generates adequate illumination for treatment of light deficient disorders including Seasonal Affective Disorder (SAD), circadian sleep disorders and circadian disruptions associated with jet-lag, shift-work, PMS, bulimia and fatigue management, which is between 2,500 and 7,500 lux, and preferably between about 3,500 and 5,500 lux at 12 inches from the assembly. To generate this level of illumination, the assembly generally includes between about 10 and 150 LEDs together having a total light output of between 50 and 500 candelas and preferably about 250 to 450 candelas. The number of LEDs in the light emitting assembly may be reduced considerably as the efficiency of a LED is increased.

Using a light therapy device according to the present invention, treatments of acceptable duration can be administered. As an example, treatments for SAD can be completed in ¼ to 4 hours and in most cases, ½ to 3 hours.

For bright-light therapy, preferably white LEDs are used. However, it is sometimes useful to combine light of different wavelengths and in some instances to approximate the spectral properties or distribution of a tropical sunrise. Therefore, LEDs 28 can be entirely of the type emitting white light or, alternatively, LEDs emitting light of various wavelengths (i.e. red or amber) can be used with white light emitting diodes. The light generated by the light emitting assembly is preferably constant, though it may also be pulsed.

In one embodiment, a diffuser screen 32 is mounted over the diodes to create a more uniform, less harsh light emission. Preferably, LEDs 28 are mounted a suitable distance from diffuser screen 32 such that the light emitted by each LED overlaps on the screen and avoids the appearance of individual points of light behind the screen. If a diffuser screen is used, it is necessary to ensure that adequate levels of light, as set out above, are passed therethrough to permit treatment.

Power is supplied to the LEDs through electrical lines 34. Power can be provided through batteries or preferably, to reduce weight, through a jack 36 for connection to a 120v electrical supply (for use in North America). The device preferably operates using DC power and is supplied with an external AC-DC converter. Since the device is particularly useful during long distance travel in the treatment of jet lag, an adapter can be provided within the device or separately for device compatibility with foreign voltages of AC power or with DC power, as is provided through power ports mounted in aircraft armrests.

To facilitate light treatment, a support leg 40 can be provided for supporting the housing in a propped position such that light is emitted in a generally horizontal direction. In one embodiment, support leg 40 is connected by a hinge 42 to the rear of the housing such that the leg can be rotated between a supporting position and a stored position against the rear of the housing. A more complex stand for elevating the light illuminating assembly can be used, as desired.

The light treatment device can be mounted permanently or removably in a vehicle passenger compartment including, for example, a passenger or operator seat area or a sleeper unit of a transport truck. The vehicle can be, for example, an aircraft, a train, a bus, a truck or an automobile. In one embodiment, the light treatment device is mounted in an aircraft seat back or in an aircraft seat armrest for use by air travelers. The device can be mounted in a manner similar to aircraft telephones, individual video monitors, and other such devices, wherein the light treatment device is attached to an adjustable extension arm, thereby enabling the user to remove the light treatment device from an armrest and position it appropriately for treatment. Alternately, the light treatment device may be temporarily removed from its seat back mounting position and positioned on a tray table or other surface for treatment, while remaining secured to the seat back by means of a cable that could also serve as a power source. The device may also be mounted into an airliner flight deck or other such areas of an airliner to provide discreet and convenient light treatments for pilots, flight attendants and other such on-board crew affected by jet lag and fatigue.

In another embodiment, the light treatment device can be mounted in the passenger compartments of vehicles, for example, automobiles, transport trucks, buses, trains, and other such vehicles, wherein the device is stored when not in use but readily available to provide a light therapy treatment. In the case of automobiles and trucks, the device may be mounted on the underside of a sun visor, or within the glove compartment, under the vehicle's dashboard, in the back seat or in the sleeper compartment. The device can be attached to an adjustable extension arm in order to permit proper positioning for treatment.

The device may also be mounted so as to provide a light treatment for the driver or operator of these vehicles, with appropriate precautions being indicated for safe operation of the vehicle, for example, at those times when the vehicle is parked or idle. One such embodiment is described hereinafter with reference to Figure 7.

Housing 10 can also be formed to accommodate other electronics, batteries etc. or to define storage space such as for cords, adapters, glasses or other items. The housing

can also include a cover or a case. Referring to Figures 4 to 6, a light therapy device according to another embodiment of the present invention is shown. The device has an outer housing including an upper housing member 110 and a lower housing member.112. The housing members are connected by a hinge 114 that permits them to pivot relative to each other between a closed position shown in Figure 4 and an open position shown in Figures 5 and 6. When in the closed position, the housing members can be releasably locked together by a catch 116. The device is small in size and, when closed, resembles a portable compact disc player or a make-up compact.

The housing encloses a light emitting assembly 20. In the illustrated embodiment, light-emitting assembly 20 is mounted in the upper housing member. The light emitting assembly is mounted on the inwardly facing portion of the upper housing member so that, when the device is in the closed position, assembly 20 is protected within the housing members. In this way, the light emitting assembly, which is more fragile than the housing, is protected against damage during transport.

The device is opened for use to administer a light treatment. In a preferred embodiment, upper housing member 110 unfolds from the closed position by rotating about hinge 114. Lower housing member 112 acts as a base for supporting the light emitting assembly. Preferably, hinge 114 is of the type that permits self-locking in at least a few rotational orientations. The use of such a hinge permits that, for example, upper housing member can be oriented to direct the light downwardly, horizontally or, if preferred, in other directions. This is useful as it may be necessary, depending on the treatment, to have the light directed into the patient's eyes or alternately downwardly toward a workspace, although reflected light may not be therapeutic.

Counterweights (not shown) can be mounted in the lower housing member to prevent the device from tipping. Member 112 can also be formed to accommodate electronics, batteries etc. or to define storage space such as for cords, adapters, glasses or other items. Member 112 can also accommodate a treatment calculator, as will be described hereinbelow.

In one embodiment illustrated, for example in Figures 1 to 3, housing 10 also accommodates a calculator including a display 82, a key pad 84 and a processor mounted within housing 10. The calculator is programmed to calculate a light treatment regime based on input of information. The calculator processor uses calculation references such as that known as the Jet Lag Calculator™ available from Bio-Brite, Inc., Maryland. In one embodiment, the calculator can be used to calculate light treatment regimes for jet lag based on inputs of information, as follows:

Option 1

i. Number of time zones crossed during trip
ii. Direction of time zones crossed (East or West)
iii. Normal wake-up time of patient (for establishing the patient's "body clock")

Option 2

i. Departure city
ii. Arrival city
iii. Normal wake-up time of patient

Based on the input of the above-noted information, the calculator will then calculate and display a treatment regime including, for example, a period of light exposure and a period of light avoidance. In option 2, the calculator determines the number of time zones through which travel will occur and uses this to calculate treatment regime. The calculator in one embodiment calculates a two-day treatment regime.

In one embodiment, the calculator keypad includes keys to be depressed when inputting particular information. As an example, the keypad can include keys such as: "departure city", "destination city" and "wake up time". The calculator can be adapted to prompt the patient such as by displaying questions requesting the appropriate information. Preferably, the calculator includes a pause function capable

of recording a time of treatment interruption and capable of outputting from memory the portion of the treatment remaining when treatment is resumed.

In addition or alternately, the calculator can be programmed for calculation of other treatment regimes such as, for example, for treatments to alleviate fatigue in shift workers or long-haul trucking or transport (i.e. truck drivers, train engineers or bus drivers). Treatments for shift workers may include inputs such as work shift start time, previous shift time and normal waking time.

A speaker 88 is preferably provided for communication to the user. As an example, the speaker can communicate with the calculator processor to audibly prompt a user to input information. In addition, the speaker can function to emit an audible signal, such as an alarm, to alert a user to commence or modify a treatment. In one embodiment, the calculator processor controls a switch for the light emitting assembly such that it is turned on or off in response to a signal from the processor.

In a preferred embodiment, the calculator memory is capable of storing previous treatment regimes. These stored treatment regimes can be recalled from processor memory for repeat trips or shift work schedules.

If desired, to enhance the usefulness of the device, the calculator can also be programmed with other information including a clock, a standard mathematical calculator or other information such as an address book, etc.

As noted hereinbefore, a light therapy device according to the present invention can be mounted in a vehicle for use by passengers or operators, preferably when not operating the vehicle. One such embodiment is illustrated in Figure 7. A vehicle mounting adaptor 50 useful for mounting a light treatment device in a vehicle passenger compartment including a back seat or a sleeper compartment acts as an interface between the vehicle power port 52 (i.e. an in-dash cigarette lighter) and the light treatment device 54. In particular, at one end the adaptor has a power port contactor 56 for insertion into the power port. A locking collar 57 is threadedly

engaged at the outboard end of the contactor 56. Once power port contactor 56 is inserted into power port 52, locking collar 57 can be tightened down about the port by threaded advancement to reinforce the engagement between port 52 and power port contactor 56.

At the opposite end, the adapter includes a docking port 58 with a recess 59 having therein electrical contactors 60. The light treatment device is mountable in the recess of docking port 58 in electrical communication with contactors 60. Venting slots 64 are formed through the docking port and positioned to substantially align with the vents 66 on light treatment device 54 to provide ventilation to the light treatment device therethrough.

Power cables (cannot be seen) extend between ends 56 and 58 to provide electrical communication therebetween. The power cables are housed within a bendable arm 68 of the type including a corrugated tube and internal supports that can be bent into various orientations and, once positioned, will hold fast in that orientation. Arm 68 is bendable yet rigid enough to hold the weight of the light treatment device 54 and docking port 58 without moving out of the bended configuration into which it has been adjusted. Locking collar 57 also securely holds power port contactor 56 in power port 52 even against the weight of the light treatment device and against the stress of bending arm 68. Adapter 50 can be removed from power port 54 and stored when not required.

To effect treatment, the light emitting assembly is directed toward the user, with the emitted light from the device shining into the user's eyes. The present device is intended to provide 'ocular' treatment for all applications and indications.

Typically, the user positions the light emitting assembly of the device between 12-24 inches from their eyes. The device can be situated on a table, desk, etc., so as to emit light upwards towards the user's eyes or supported in other ways such as by the bending arm of Figure 7.

The user's eyes must be open to effect treatment. It is not necessary for the user to stare directly into the light from the device. Indeed, the light is sufficiently bright so that the user instinctively knows not to do so.

Treatment times for SAD are typically 15-30 minutes/day. Users have reported that the most effective times being first thing each morning during the 'seasonal' period for S.A.D. (in the northern hemisphere including N. America, northern Europe, etc., the SAD season is Sept - March annually).

Treatment times to 'seek light' for 'jet-lag' are typically a 3-hour period, as determined by the user's inputs for departure city, arrival city, and normal waking time. A similar period is recommended to 'avoid light', wherein the user wears the light-blocking glasses if outdoors in direct sunlight. Users have reported that a substantially shorter light therapy treatment period has effected the desired benefit; in some cases, as short as 45 minutes on Day 1 of travel, and 15 minutes on Day 2 effected a complete 6 time zone shift.

Treatment regimens for additional applications, e.g. PMS, Delayed Sleep Phase Syndrome, etc. typically indicate a treatment regimen of similar duration as for SAD, except that treatment occurs in the evening (to delay the onset of melatonin secretion).

Treatment for fatigue management may include short light treatments using the light device of the present invention, after a rest period and prior to initiating work or normal activities.

Numerous modifications, variations and adaptations may be made to the particular embodiments of the invention described above without departing from the scope of the invention as defined in the claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A light therapy device comprising:
an outer housing including an opening; and
a light emitting assembly in the housing and operable to emit light through the opening in the housing, the light emitting assembly including a plurality of LEDs together capable of generating 2,500 lux to 7,500 lux at 12 inches.

2. The light therapy device of claim 1 wherein at least some of the LEDs are capable of emitting white-light.

3. The light therapy device of claim 1 wherein a diffuser screen of light diffusing sheet material is positioned over the LEDs.

4. The light therapy device of claim 1 wherein the housing accommodates a therapy calculator for determining a treatment regime based on an input of information.

5. The light therapy device of claim 1 wherein the housing includes a first member and a second member, the first member and the second member being releasably locked together and the light emitting assembly being storable in the first member and being mountable on the housing such that the housing acts as a base to support the light emitting assembly.

6. The light therapy device of claim 5 wherein the first and second members are pivotally connected.

7. The light therapy device of claim 6 wherein the light emitting assembly is mounted onto the first member and the second member forms a base for support of the first member.

8. The light therapy device of claim 1 wherein the housing is mounted into a vehicle passenger compartment so as to provide light treatment to vehicle passengers or operators.

9. The light therapy device of claim 1 further comprising an adjustable arm mounted to the housing and useful for supporting the device in a selected position.

10. A method for administering an ocular light treatment to an individual, the method comprising:

providing a light therapy device including an outer housing having an opening; and a light emitting assembly in the housing and operable to emit light through the opening in the housing, the light emitting assembly including a plurality of LEDs together capable of generating 2,500 lux to 7,500 lux at 12 inches; and

directing the emitted light toward the eyes of the individual.

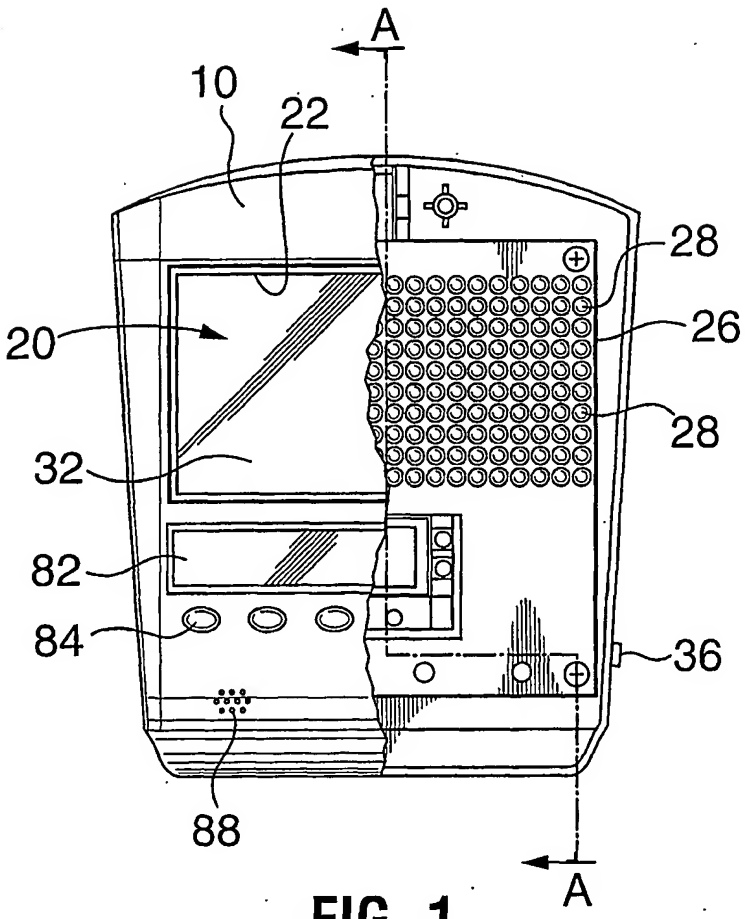

FIG. 1

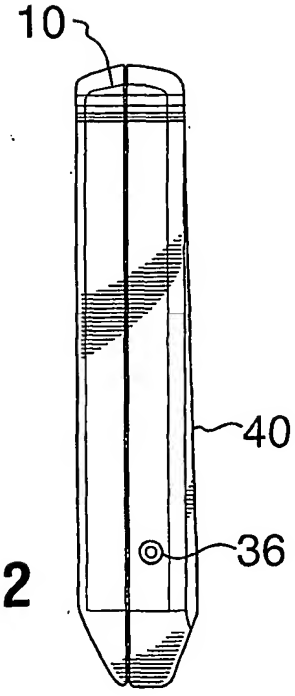

FIG. 2

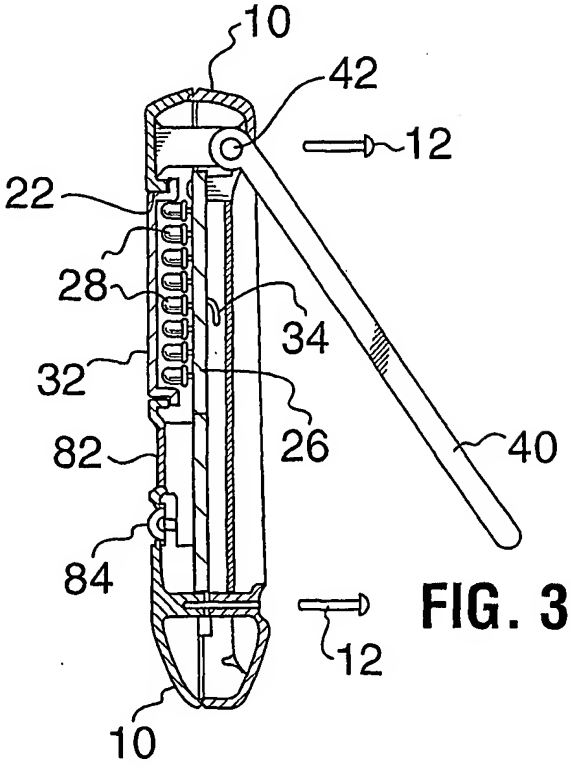

FIG. 3

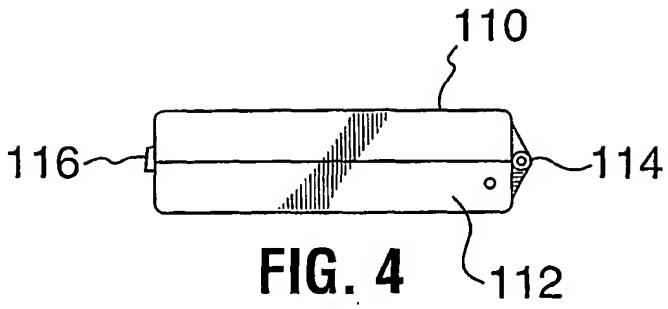

FIG. 4

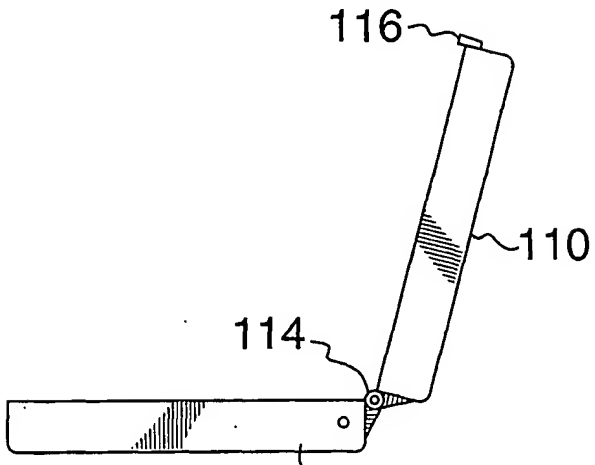

FIG. 5

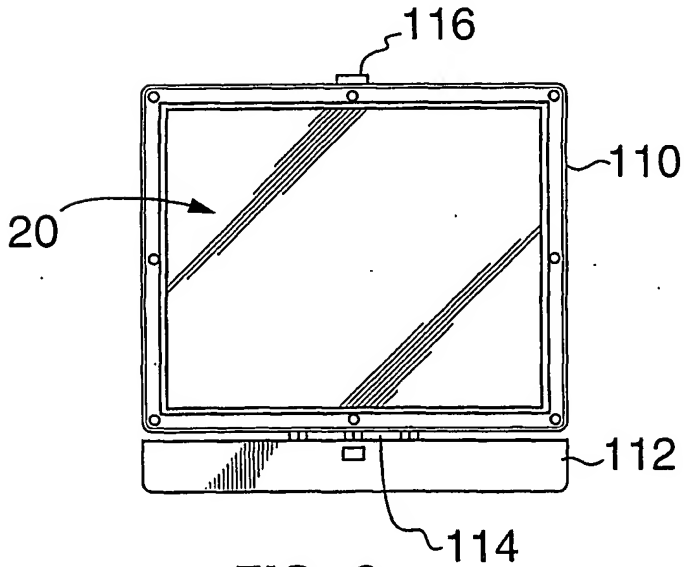

FIG. 6

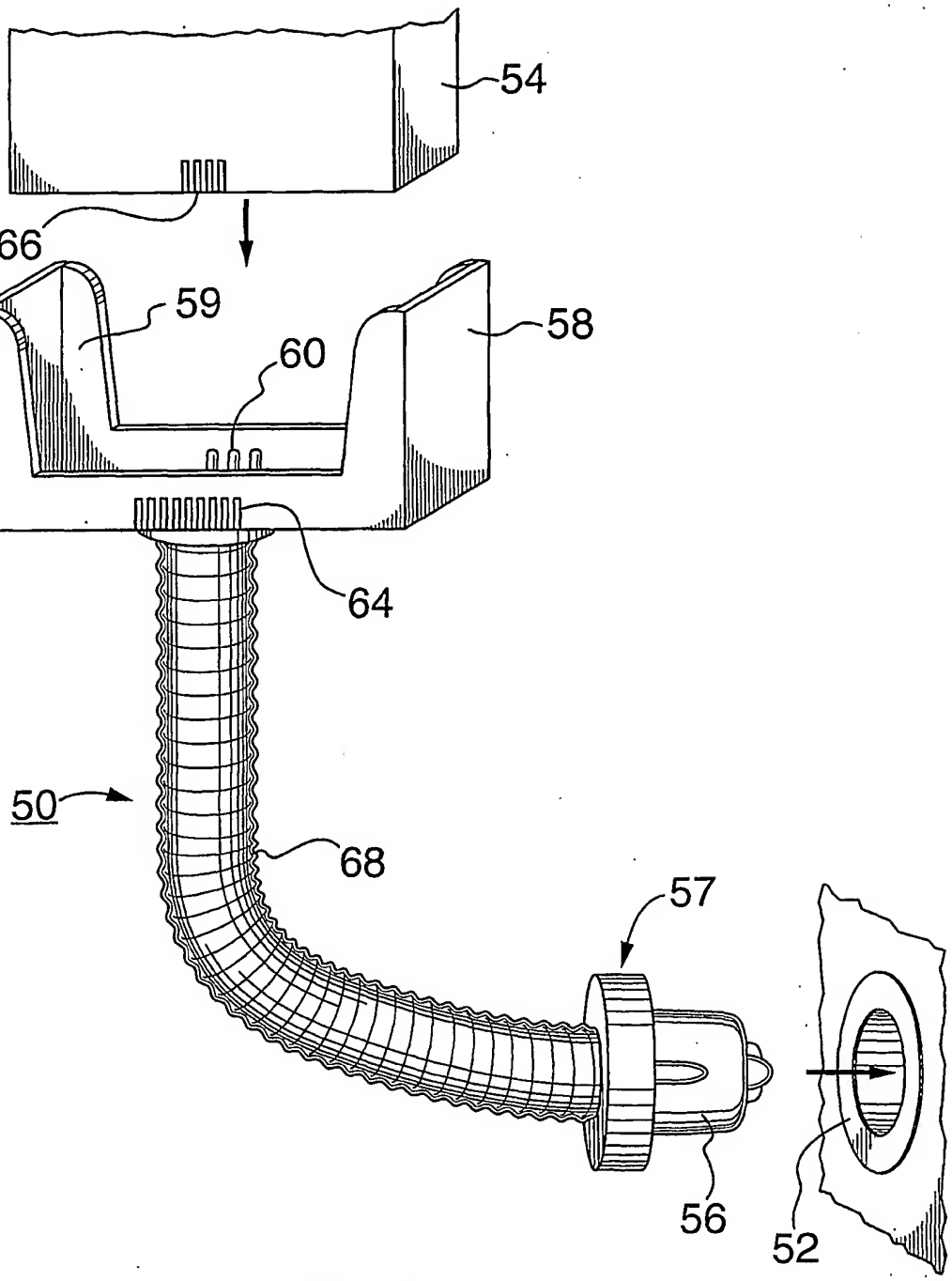

FIG. 7

INTERNATIONAL SEARCH REPORT

Int« nal Application No
PCT/CA 01/00333

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61M21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61M A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 149 184 A (HUGHES PHILIP ET AL) 22 September 1992 (1992-09-22) column 2, line 48 -column 3, line 57	1-3,5-7, 9
Y	WO 98 51372 A (CORNELL RES FOUNDATION INC) 19 November 1998 (1998-11-19) page 7, line 10 - line 31 page 16, line 25 -page 17, line 9	1-3,5-7, 9
A	US 5 304 212 A (CZEISLER CHARLES A ET AL) 19 April 1994 (1994-04-19) column 65, line 30 -column 67, line 37	4,8
A	US 5 197 941 A (WHITAKER BARBARA) 30 March 1993 (1993-03-30) column 5, line 7 - line 38; figure 2	1,5-7

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 August 2001	28/08/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Petter, E

Form PCT/ISA/210 (second sheet) (July 1992)

12/19/05, EAST Version: 2.0.1.4

INTERNATIONAL SEARCH REPORT

Inte nal Application No
PCT/CA 01/00333

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 196 37 535 A (SAMARIT MEDIZINTECHNIK AG) 19 March 1998 (1998-03-19) the whole document	1,5-7

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

12/19/05, EAST Version: 2.0.1.4

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte nal Application No
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